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RESEARCH ARTICLE

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A STUDY AND ANALYSIS OF BEHAVIOUR OF THE FERRO CONCRETE AS A PAVEMENT SURFACING MATERIAL

BASAVARAJA N H[1], ARPITHA[1], MOHAN KUMAR K M[1], SYYED KHALID MUZAFFER[2], AMJAD V K[2], FUAD SANEEN M[2], IRFAN M P[2]

[1]Assistant Professors, Department of Civil Engineering, Bearys Institute of Technology, Mangalore, VTU, Karnataka, India

[2]Students, Department of Civil Engineering, Bearys Institute of Technology, Mangalore, VTU, Karnataka, India

BASAVARAJA N H

ARPITHA

MOHAN KUMAR K

ABSTRACT

The purpose of a pavement is to carry traffic safely, conveniently and economically over its extended life. The main objective of this project work is to use the ferro concrete as materials for the study and analysis of pavement. As we all know that the cost for the construction of flexible pavement or rigid pavements through bitumen or reinforced cement concrete respectively is more, to minimise this, our aim is to provide an economically suitable design of pavement through the use of ferro concrete materials. Ferro concrete is a thin composite made with a cement based mortar matrix reinforced with closely spaced layers of relatively small diameter wire mesh. It is used to construct relatively thin, hard, strong surfaces and structures in many shapes such as hulls for boats, shell roofs, and water tanks. The pavements are mainly of two type's mainly flexible pavements and rigid pavements. Flexible pavements are those which are surfaced with bituminous (or asphalt) materials. These types of pavements are called "flexible" since the total pavement structure "bends" or "deflects" due to traffic loads. A flexible pavement structure is generally composed of several layers of materials which can accommodate this "flexing". Flexible pavements comprise more than 90 percent of our paved roads.

Keywords—Ferro Contere, Flexible Pavement, Mild Steel, Chicken Mesh, Specific Gravity, Dial Gauge.

1. INTRODUCTION

At the present time Indian roads are presently constructed with not the right choice of material. As the project view is to go for the construction of rigid pavement through the use of ferro concrete materials. Rigid pavement is those which possess noteworthy flexural strength or flexural rigidity. The stresses are not transferred from grain to grain to the lower layer as in the case of flexible pavement layer. The rigid pavements are made of Portland cement concrete or plain, reinforced or pre stressed concrete but the objective is to provide ferro concrete on place of it.

Ferro concrete is a type of thin reinforced concrete laminates commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small size wire mesh. Ferro concrete, glass fibre, aramid fibre, carbon fibre, etc. are some of the few materials that are used in the confinement of concrete columns. Behaviour of such ferro concrete is studied which includes following mechanical properties for

determining the relations between the tensile strength of ferro concrete with respect to the specific surface using various combination of mortar and meshes which is to be used in ferro concrete i.e, Tensile strength, Compressive strength, Split tensile strength.

The flexible pavements consist of wearing surface built over a base course and they rest on compacted subgrade. The design of a flexible pavement is based on the principle that a surface load is dissipated by carrying it deep into the ground through successive layer of granular materials. Flexible pavements with asphalt concrete surface courses are used all around the world. It possesses negligible flexural strength compared to rigid pavements. In flexible pavements, joints are not required.

2 FERRO CONCRETE

Ferro concrete (FC) is defined as wire mesh reinforcement impregnated with mortar to produce elements of small thickness, high durability and resilience and, when properly shaped high strength and rigidity. These thin elements can be shaped into structural members such as "flanged" beams (e.g. Box-beams and I beams), folded plates, wall panels, etc. Considerable progress in research towards developing ferro concrete as an efficient building material has been achieved in the last two decades. Its increase in use as a building material has motivated researchers and engineers to study ferro concrete structural elements and formulates design guidelines for them. The behaviour of ferro concrete in flexure has been observed to be very similar to that of reinforced concrete members. However it has been found that a ferro concrete is considered as a hybrid material between reinforced concrete and steel In developing countries, the raw materials for ferro concrete construction are easily available, and also it could be constructed in any complicated shape. The skill required is of low level and it has superior strength properties as compared to conventional reinforced concrete. These are the reasons for which the ferro concrete is considered to be an appropriate confinement material in developing countries such as India. The development of innovative rehabilitation and strengthening technique is required to extend the life expectancy of many concrete structures. The above mentioned factors have contributed to motivate researchers to unleash the potential of using composite materials to retrofit and strengthen the structures. Procedures that are technically sound and economically feasible are needed to upgrade the deficient structures.

3 FLEXIBLE PAVEMENTS

Flexible pavements will transmit wheel load stresses to the lower layers by grain-to-grain transfer through the points of contact in the granular structure (Fig 1). The wheel load acting on the pavement will be distributed to a wider area and the stress decreases with the depth. Taking advantage of this stress distribution characteristic, flexible pavements normally has many layers. Hence, the design of flexible pavement uses the concept of layered system. Based on this, flexible pavement may be constructed in a number of layers and the top layer has to be of best quality to sustain maximum compressive stress, in addition to wear and tear. The lower layers will experience lesser magnitude of stress and low quality material can be used. Flexible pavements are constructed using bituminous materials. These can be either in the form of surface treatments or, asphalt concrete surface courses Flexible pavement layers reflect the deformation of the lower layers on to the surface layer (e.g., if there is any undulation in sub-grade then it will be transferred to the surface layer). In the case of flexible pavement, the design is based on overall performance of flexible pavement, and the stresses produced should be kept well below the allowable stresses of each pavement layer.

Fig.1 Typical cross section of a flexible pavement

4 SPECIFIC GRAVITY OF THE MATERAILS

The main before casting the slab was checking the specific gravity of the materials. The apparatus that

is used to check the specific gravity of cement is Le-Chatelier flask, kerosene i.e., free from water and specific gravity bottle at constant temperature.The specific gravity of fine and coarse aggregate is calculated with the help of pyconometer. IS sieve of sizes 12.5mm and 10mm for sieving the aggregates.

Result: The Specific Gravity of

- Specific gravity of Ordinary Portland cement S_c = 3.15
- Fine Aggregate = 2.65
- Coarse Aggregate = 2.70

5 AIM & OBJECTIVES OF THE WORK

The main aims and objectives of this project are as follows:

- To study the characteristics of ferrocement as a pavement material.
- To study the stability of Ferro concrete as to whether it stands the heavy loads coming onto the slab.
- To study the amount of deflection that is taking place after the heavy loads are passing through the ferro concrete slab.
- To minimise the cost of construction that is required for the construction of rigid pavements through reinforced cement concrete structures.
- To study its behaviour as an all-weather road.

6 MATERAIL AND METHODOLOGY

The materials that are used in the preparation of Ferro concrete slab is Ordinary Portland cement i.e., of 53 grade, fine aggregate that was taken from river, 10mm down size coarse aggregate, mixing water was used. For the skeleton, 4mm mild steel rods were used. Chicken mesh was used which was boundary around the skeleton.

- **Cement** In this experimental work, 53 grades Ordinary Portland cement (OPC 53) IS: 8112-1989 was used
- **Fine aggregate** Natural river sand of zone I was used. Specific gravity, moisture content and absorption capacity of fine aggregate is calculated according to the procedure.
- **Coarse aggregate** Coarse aggregate of 10 mm down size was used. Specific gravity, moisture content and absorption capacity of Coarse aggregate is calculated according to the procedure.
- **Mild steel** Mild Steel of 4mm diameter round rods were used. The density of mild steel is 7850 kg/m^3 and Young's modulus is 210 GPa. These rods are commercially available and are generally used in mechanical the industry, workshops etc.
- **Chicken mesh** Chicken mesh usually has in hexagonal shape and its is made up of material know as galvanized low carbon wire,annealed wire.The daiameter of the wire mesh from 0.6 to 2.0mm. Chicken wire mesh was used which was boundary around the skeleton and it has specific properties for plastering use.

7 PREPARATION AND CASTING OF SPECIMEN

- **Preparation of Skeleton** The first and the foremost step of preparation of casting a ferroconcrete slab is the preparation of skeleton. Mild steel rods of 4mm dia are collected and are cut into 1 m equal length. The marking are done at equal interval of 9.09cm from each other and the mild steel rods are placed over it. After placing, each junction of the mild steel rod is welded and skeleton is ready for further step.
- **Fixing of Mesh** After the preparation of skeleton, the next step is fixing the chicken mesh. The chicken mesh is wound on 2 sides of the skeleton and is rolled through the metal rods for proper fixing of the mesh in its place. It is pulled slowly so that the hexagonal shape of the skeleton doesn't change its shape.
- **Preparation of Mould** The step after fixing the mesh is the preparation of mould. 2" thick wooden logs are taken and are fixed on all the corners by the use of nail. The exact measurement is noted and the diagonals are checked out. After fixing the proper measurement, the floors were the

slab is to be casted is oiled or greased. Oil or grease is applied so that the removal of slab on the next day of casting will be easy and can be kept for curing processes.

- **Mixing of Concrete**
  The mixing of concrete is done after the preparation of mould. OPC 53 grade cement is taken and as per the design mix, the proportion is put and mixed. 8mm down size coarse aggregate is used along with Zone 1(river sand). The required amount of water is mixed. The design mix is $M_{20}$with the proportion 1:2:4. The compaction factor is 0.9 and the condition is light exposure condition

Fig. 7.1 Welding of skeleton structure

Fig. 7.2 Wovening of chicken mesh

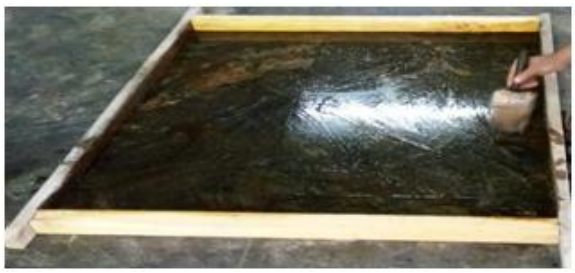

Fig. 7.3 Oiling of mould

- **Casting of Slab** During the casting of the slab, the skeleton rolled with chicken mesh is kept at the bottom with a small covering. The concrete mix is then put into mesh slowly as to see there are no voids are present in it. Concrete mixture is applied and hand compaction is done that the coarse aggregate enters the mesh. After applying on 1 layer of the concrete, another mesh is kept over the concrete and in the same way the concrete is put up and hand compacted up to the 2" mark of the mould. After completing to the 2" level, cement is put on the surface for proper holding of the mortar and it is again leveled. After leveling, rough surface is made using broom stick for grip on the slab. After 1 day, the slab is removed from the surface of the floor and is kept for curing in the curing tank for 28 days. After proper curing for 28 days, the slab is brought in place for test.

Fig. 7.4 Placing of skeleton mesh in mould

Fig. 7.5 Concreting of slab

Fig. 7.6 Finished layer of slab

- **Placing of Slab** For the placing of the slab, as per the design of the pavement, a depth of around 13.57cm is dig deep into the ground. A boulder are first put and is compacted to a layer and is then filled with coarse aggregate of 20mm down size and is again compacted. It is put up and is compacted until its gets settled. After compaction of the coarse aggregates, the slab is placed in the pit of 3m×1m and placed

accordingly. Rubber piece is cut into 2" thickness and is then placed in between the joints and is joined by cement mortar. Care must be taken that after placing the rubber, there should not be any gap between the slabs.

The sides should then be filled with the aggregates and sand and should be compacted properly. It should be checked that there is no movement in the slabs after compaction.

Fig.7.7 Completed pavement surface

- **Testing of Slab** For the testing of the slab, dial gauge is fixed on the slab by holding the dial gauge on the slab by the means of a holder which is grounded by a wooden block. The reading is fixed to 0. The vehicles are then moved on the slab which is attached to the dial gauge. During movement of the wheel, there is deflection shown in the slab. The reading is noted down.

  After the movement of vehicles, the deflection is noted down and is multiplied by the least count of dial gauge to get the deflection value.

Fig. 7.8 Dial gauge fixed to slab

8 EXPERIMENTAL INVESTIGATION

The test was conducted after the placing of slab on the testing place. 3 vehicles of different wheel loads were passed on the slab and the deflection was noted down in the dial gauge. The vehicles were passed through the slab and the deflection was observed by the each moving wheel of the vehicles. As the wheel load on the slab got increased, the deflection was observed more. There were no cracks developed on the slab. It stated that the slab is able to take heavy wheel load if the pavement is designed properly. The deflection observed was comparatively very less. The deflectionΔ values are as follows:

Table 7.1Experimental results of Deflections

Vehicle	Calculation (Δ*LC)	Deflection (mm)
Car	8*0.01	0.08
Mini Bus front wheel	96*0.01	0.96
Mini Bus back wheel	178*0.01	1.78
Bus front wheel	100*0.01	1
Bus back wheel	180*0.01	1.8

9 RESULT AND DISCUSSIONS

The results that were conducted on the Ferro concrete as a pavement surfacing materials, we have come to a conclusion that it can hold heavy loads coming onto it as Ferro concrete gives large amount of compressive strength to the concrete structures. It can hold the large amount of wheel load coming on it. It does not crack on the application of heavy loads onto the slab. By comparing with the normal RCC structures, the replacement of Ferro concrete slab is easy as slabs can be replaced if damage occurs whereas RCC structures sizes are big and it cannot be replaced. Ferro concrete slabs can be used for major district roads (MDR) and village roads (VR). The deflection value was very less and it can be concurred that Ferro concrete slabs can be used for the construction of pavement.

10 CONCULSION

The conclusion of this study says that the Ferro concrete slab can be used for the pavements and it can be used instead of RCC structures. It can be used for major district roads (MDR) and village roads (VR). The deflection value was very less and it can be concurred that Ferro concrete slabs can be used for the construction of pavement. Replacement of Ferro concrete slabs is easy compared to RCC slabs.

11 FUTURE SCOPE

There are a lot of studies that can be carried out by Ferro concrete in the field of construction of pavement.

- Joint design can be studied for joining of slabs on the pavement.
- The study of behaviours such as like friction, stresses at corner, edge and centre can be further studied.
- The characteristics of ferrocement as pavement materials like durability, rigidity, surface wear and tear, pavement rutting and undulation of pavements can be further detailed and explored.
- Comparative study can be carried out between Ferro concrete and RCC rigid pavements.
- Details can be collected and checked out to whether it is an all-weather road.

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	**SYYED KHALID MUZAFFER** Student, Department of Civil Engineering, Bearys Institute of Technology, Mangalore,VTU, Karnataka, India
	**AMJAD V K** Student, Department of Civil Engineering, Bearys Institute of Technology, Mangalore,VTU, Karnataka, India
	**FUAD SANEEN M** Student, Department of Civil Engineering, Bearys Institute of Technology, Mangalore,VTU, Karnataka, India
	**IRFAN M P** Student, Department of Civil Engineering, Bearys Institute of Technology, Mangalore,VTU, Karnataka, India